REMARKS

Claims 1-25 and 28-30 are pending in the application. Claims 1 and 7 have been amended, and claims 26-27 have been cancelled. Further, claims 8-25 have been withdrawn pursuant to a restriction requirement. No new matter has been introduced by the amendment.

Rejection Under 35 U.S.C. §102(b) and alternatively Under 35 U.S.C. § 103(a)

Claims 1-6 have been rejected over Yamakawa (JP-5200539). This rejection is overcome in view of the amendment of claim 1, together with the following remarks.

Claim 1, as amended, recites a method for sealing two substrates in a microstructure. The method includes depositing a first rim onto a surface of a first substrate. The first rim includes an upper rim and a lower rim. The upper rim comprises a sealing material that interdiffuses spontaneously with a material of a second substrate. The lower rim comprises an adhesive material that adheres the first substrate to the sealing material of the upper rim. A second rim is deposited on the second substrate. The second rim faces the first rim and comprises a layer of the sealing material.

In accordance with the invention, the second rim overlies a surface of at least one protuberance on the second substrate. The at least one protuberance has a plurality of hollows or a mesh structure and is adapted to channel the diffusion of the sealing material. The sealing method includes bringing the upper rim and the second rim into contact and heating the sealing material to interdiffuse the sealing material and the material of the second rim. During the heating step, the at least one protuberance channels the diffusion of the sealing material.

As described by the applicants in their specification, the protuberances channel the diffusion of the sealing material to encourage depth wise diffusion and to increase the pressure exerted on the contact area at the time of assembly. (Specification, ¶ 0017). Portions of the molten sealing material are retained in the hollows or mesh structure and prevent the sealing material from being discharged laterally as a result of the contact pressure applied during assembly. (Specification, ¶ 0027).

The sealing structure is advantageously assembled by depositing the second rim onto a face of the second substrate. (Specification, ¶ 0053).

The applicants assert that Yamakawa does not suggest or disclose the applicants' bonding method. To better discuss the method disclosed by Yamakawa, the applicants refer herein to European Patent Application No. 0552466. This European patent application corresponds to the cited Japanese reference (JP-05200539). For the convenience of the Examiner, a copy of this published European patent application is included herewith. Yamakawa discloses a method for joining semiconductor substrates and is based on an Au-Si eutectic soidering. (Col. 4, ll. 24-30, and FIG. 1). In the bonding process, heating of the substrates is conducted in a nitrogen atmosphere. (Col. 3, ll. 42-44). If the material of the substrate is different than silicon, a titanium adhesive layers can be added. (See FIG. 2). Gold is deposited on one of the substrates as needed. (Col. 4, ll. 55 to Col. 5, ll. 1). An interior groove is created by etching both substrates using a SiN mask pattern. (Col. 5, ll. 9-16).

The applicants assert that Yamakawa does not suggest or disclose the channeling of sealing material into a substrate by means of a protuberance. Again, as noted by the applicants, the channeling of sealing material during the heating step has numerous advantages for creating a seal between two microstructure substrates. In contrast, the method disclosed by Yamakawa does not provide a reservoir for sealing material nor protuberances structured to channel the sealing material during a heating step. Accordingly, the applicants assert that claim 1 is allowable over Yamakawa.

Claims 2-6 depend directly from claim 1. These claims are allowable at least in view of the amendment and remarks pertaining to claim 1.

Rejection Under 35 U.S.C. §103(a)

Claims 26-27 have been rejected over Yamakawa in view of Yoshihara et al. (US 6,555,901). Claims 26-27 have been cancelled to maintain correspondence with the amendment of claim 1 from which they formerly depended. The rejection of these claims is now moot in view of their cancellation. Further, the applicants assert that claim 1, as amended, is allowable over the combination of Yamakawa and Yoshihara et

al. Neither reference suggests or discloses a method of sealing two substrates in which structure on at least one protuberance channels the diffusion of sealing material upon heating the sealing material. Although Yoshihara et al. disclose sealing a silicon portion and a gold layer where an uneven surface forms an interface between the two bodies, the microscopic irregularity does not include hollows or a meshed structure that provides a reservoir for sealing material and channels the sealing material during a heating step. Instead, Yoshihara et al. form eutectic regions (116a-d) (Col. 10, ll. 4-18). Upon further heating, the eutectic regions melt together and form an entire area of the interface between the silicon portion and the gold layer. (FIG. 33).

Further, in the process of Yoshihara et al. the bulk material of the substrate is not involved in the sealing process. Instead, the silicon bonding frame (21) is employed to form the seal. Accordingly, Yoshihara et al. teaches away from the claimed invention in which the sealing process involves the bulk material of one of the two substrates. Accordingly, the applicants assert that, to the extent the rejection of former claims 26 and 27 relates to amended claim 1, amended claim 1 is allowable over the cited combination references.

Claim 7 and 19 have been rejected over Yamakawa in view of Saito et al. (JP-2001150398). This rejection is overcome at least in view of the amendment of claim 1 together with the following remarks. Claim 7 depends from claim 2 and recites that the barrier comprise tungsten. Claim 7 has been amended to improve its form by removing the term "layer," following the term "barrier." Claim 2 depends from claim 1 and specifies that the sealing material and the material of the first substrate comprise materials that diffuse into each other, and further recites that the lower rim forms a barrier to diffusion.

Claim 19 depends from claim 3 and recites that the barrier comprises tungsten. Claim 3 depends from claim 1 and specifies that sealing material and the material of the first substrate comprised material that diffuse into each other. Claim 3 further recites that the first rim also includes a layer forming a barrier to diffusion between the lower rim and the upper rim. Despite the disclosure by Saito et al. of tungsten as one of several materials that can form a diffusion prevention layer, the applicants assert that

the addition of Saito et al. does not overcome the deficiencies of Yamakawa. Neither reference suggests or discloses at least one protuberance having a plurality of hollows or a mesh structure adopted to channel the diffusion of sealing material.

New Claims

Claims 28-30 are newly added to the application in order that the applicants can more fully claim the subject matter of their invention. Claim 28 depends from claim 1 and recites that the method further includes etching the second substrate using the second rim as an etch mask to form the at least one protuberance. As described by the applicants, the rim 32 serves as a mask during an etching step in which a cavity 35 is obtained in a portion of the thickness of the substrate 30 and surrounded by a continuous wall or protuberance 36. (Specification, ¶ 0055 and FIG. 6). The applicants assert that claim 28 distinguishes over the cited references at least because none of the cited references suggest or disclose using a second rim as a etch mask to form protuberances.

Claim 29 depends from claim 1 and recites that the upper rim is configured to form a reservoir for the ceiling material. Claim 29 further recites that the configuration of the upper rim facilitates innerdiffusing the ceiling material and the material of the second substrate. As disclosed by the applicants, the dimensions of the rim 22B are sufficient to guarantee that there is sufficient gold to be able to diffuse into the silicon and hence provide a good seal. (Specification, ¶ 0063). The upper the rim provides a reservoir function for the seal and forms a barrier preventing gold from diffusing toward the interior of the thin layer 20. The applicants assert that claim 29 is allowable over the cited references.

Claim 30 depends from claim 1 and recites that the plurality of hollows or mesh structure is configured to retain molten sealing materials. (Specification, ¶ 0063). The applicants assert that the cited combination of references does not suggest or disclose the method recited by claim 30.

The applicants have made a novel and non-obvious contribution to the art of sealing substrates in a microstructure. The pending claims distinguish over the cited references and are in condition for allowance. Accordingly, such allowance is now earnestly requested.

Respectfully submitted,

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